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Image Processing Apparatus and Method Thereof and Storage Medium

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[Abstract]

[Object]

To improve a compression ratio of an image by reducing the number of colors in a color-reduced image.

[Solution]

If the number of palettes of a character area has been 1 (S1901), a character area portion of a full-page binarized image is cut out to generate a one-portion binary image (S1907). It becomes a color-reduced image of the character area. On the other hand, if the number of the palettes is more than or equal to 2 (S1901), a color reduction unit 1082 inputs an original image 101 and the full-page binarized image, sorts a value in the original image of a pixel which is black in the binary image within the character area, into a value of the palette, and generates the color-reduced image (S1902). Then, a representative color is

extracted for each one character by using coordinate information on each one character according to the above described color-reduced image and character segmentation information (S1903), and character pixels in that one character area are redrawn with the representative color (S1904). This process is repeated with respect to all character coordinates, and thereby a final color-reduced image is obtained. The above described process is performed with respect to all character areas (S1906).

[What is Claimed IS:]

[Claim 1]

An image processing apparatus characterized by comprising:

character area detection means for, if a character area is included in an image, detecting said character area;

ground image generation means for generating a ground image in which a character portion included in the character area has been filled with a predetermined color;

palette generation means for generating palettes of colors representing the character area; and

color-reduced image generation means for, in a first color-reduced image of said character area, in which if the number of the palettes of the colors in the character area is one, an image in which said character area has been binarized has been set to the color-reduced image of said character area, and if the number of the palettes of the colors in the character area is multiple, the color-reduced image has been generated by using the palettes of the colors in said character area, generating a second color-reduced image of said character area by extracting a representative color in the character portion included in the character area of said first color-reduced image and drawing pixels constituting said character portion by

using said representative color.

[Claim 2]

The image processing apparatus according to claim 1, characterized by further comprising binarization means for binarizing the image,

wherein said character area detection means detects the character area included in the image by using a binarized image of said image generated by said binarization means.

[Claim 3]

The image processing apparatus according to claim 1, characterized in that said character area detection means detects the character area included in said image from an image in which a differential process has been applied with respect to said image.

[Claim 4]

The image processing apparatus according to claim 3, characterized in that said character area detection means detects the character area by applying a differential filter to said image to calculate an edge amount of all pixels with neighboring pixels and performing a contour tracing with respect to an image in which the edge amount has been binarized.

[Claim 5]

The image processing apparatus according to claim 1, characterized by further comprising segmentation means for segmenting the image into areas of a

predetermined size.

[Claim 6]

The image processing apparatus according to claim 1, characterized in that said ground image generation means further has average color calculation means for calculating an average color of colors in areas other than the character portion in the character area; and

said character portion is filled by using the average color calculated by said average color calculation means.

[Claim 7]

The image processing apparatus according to claim 1, characterized by further comprising JPEG compression means for JPEG-compressing the ground image generated by said ground image generation means.

[Claim 8]

The image processing apparatus according to claim 7, characterized in that the ground image to be compressed by said JPEG compression means has been reduced.

[Claim 9]

The image processing apparatus according to claim 7, characterized in that the ground image to be compressed by said JPEG compression means is reduced with a reduction ratio depending on areas having a large coefficient in a high frequency part when said ground image has been orthogonally transformed.

[Claim 10]

The image processing apparatus according to claim 1, characterized by further comprising color-reduced image compression means for compressing the color-reduced image of the character area generated by said color-reduced image generation means, with a compression method depending on the number of the palettes of the colors in said character area.

[Claim 11]

The image processing apparatus according to claim 10, characterized in that if the number of the palettes of the colors in the character area is one, said color-reduced image generation means performs an MMR compression with respect to the color-reduced image of said character area, and if the number of the palettes of the colors in said character area is multiple, said color-reduced image generation means performs a ZIP compression with respect to the color-reduced image of said character area.

[Claim 12]

The image processing apparatus according to claim 1, characterized in that, among the palettes generated by said palette generation means, a palette of a color which has not been used by said color-reduced image generation means is deleted.

[Claim 13]

An image processing method characterized by

comprising:

a character area detection step for, if a character area is included in an image, detecting said character area;

a ground image generation step for generating a ground image in which a character portion included in the character area has been filled with a predetermined color;

a palette generation step for generating palettes of colors representing the character area; and

a color-reduced image generation step for, in a first color-reduced image of said character area, in which if the number of the palettes of the colors in the character area is one, an image in which said character area has been binarized has been set to the color-reduced image of said character area, and if the number of the palettes of the colors in the character area is multiple, the color-reduced image has been generated by using the palettes of the colors in said character area, generating a second color-reduced image of said character area by extracting a representative color in the character portion included in the character area of said first color-reduced image and drawing pixels constituting said character portion by using said representative color.

[Claim 14]

The image processing method according to claim 13,

characterized by further comprising a binarization step for binarizing the image,

wherein said character area detection step detects the character area included in the image by using a binarized image of said image generated by said binarization step.

[Claim 15]

The image processing method according to claim 13, characterized in that said character area detection step detects the character area included in said image from an image in which a differential process has been applied with respect to said image.

[Claim 16]

The image processing method according to claim 13, characterized by further comprising a segmentation step for segmenting the image into areas of a predetermined size.

[Claim 17]

The image processing method according to claim 13, characterized in that said ground image generation step further has an average color calculation step for calculating an average color of colors in areas other than the character portion in the character area; and

said character portion is filled by using the average color calculated by said average color calculation step.

[Claim 18]

The image processing method according to claim 13, characterized by further comprising a JPEG compression step for JPEG-compressing the ground image generated by said ground image generation step.

[Claim 19]

The image processing method according to claim 13, characterized by further comprising a color-reduced image compression step for compressing the color-reduced image of the character area generated by said color-reduced image generation step, with a compression method depending on the number of the palettes of the colors in said character area.

[Claim 20]

The image processing method according to claim 19, characterized in that if the number of the palettes of the colors in the character area is one, said color-reduced image generation step performs an MMR compression with respect to the color-reduced image of said character area, and if the number of the palettes of the colors in said character area is multiple, said color-reduced image generation step performs a ZIP compression with respect to the color-reduced image of said character area.

[Claim 21]

The image processing method according to claim 13, characterized in that, among the palettes generated by said palette generation step, a palette of a color

which has not been used by said color-reduced image generation step is deleted.

[Claim 22]

A computer-readable storage medium storing program codes, characterized by comprising the program codes of:

a character area detection step for, if a character area is included in an image, detecting said character area;

a ground image generation step for generating a ground image in which a character portion included in the character area has been filled with a predetermined color;

a palette generation step for generating palettes of colors representing the character area; and

a color-reduced image generation step for, in a first color-reduced image of said character area, in which if the number of the palettes of the colors in the character area is one, an image in which said character area has been binarized has been set to the color-reduced image of said character area, and if the number of the palettes of the colors in the character area is multiple, the color-reduced image has been generated by using the palettes of the colors in said character area, generating a second color-reduced image of said character area by extracting a representative color in the character portion included in the

character area of said first color-reduced image and drawing pixels constituting said character portion by using said representative color.

[Claim 23]

The storage medium according to claim 22, characterized by further comprising the program code of a binarization step for binarizing the image,

wherein said character area detection step detects the character area included in the image by using a binarized image of said image generated by said binarization step.

[Claim 24]

The storage medium according to claim 22, characterized in that said character area detection step detects the character area included in said image from an image in which a differential process has been applied with respect to said image.

[Claim 25]

The storage medium according to claim 22, characterized by further comprising the program code of a segmentation step for segmenting the image into areas of a predetermined size.

[Claim 26]

The storage medium according to claim 22, characterized in that the program code of said ground image generation step further has the program code of an average color calculation step for calculating an

average color of colors in areas other than the character portion in the character area; and

said character portion is filled by using the average color calculated by said average color calculation step.

[Claim 27]

The storage medium according to claim 22, characterized by further comprising the program code of a JPEG compression step for JPEG-compressing the ground image generated by said ground image generation step.

[Claim 28]

The storage medium according to claim 22, characterized by further comprising the program code of a color-reduced image compression step for compressing the color-reduced image of the character area generated by said color-reduced image generation step, with a compression method depending on the number of the palettes of the colors in said character area.

[Claim 29]

The storage medium according to claim 28, characterized in that if the number of the palettes of the colors in the character area is one, said color-reduced image generation step performs an MMR compression with respect to the color-reduced image of said character area, and if the number of the palettes of the colors in said character area is multiple, said color-reduced image generation step performs a ZIP

compression with respect to the color-reduced image of said character area.

[Claim 30]

The storage medium according to claim 22, characterized in that, among the palettes generated by said palette generation step, a palette of a color which has not been used by said color-reduced image generation step is deleted.

[Detailed Description of the Invention]

[0001]

[Industrial Field Of Utilization]

The present invention relates to an image processing apparatus which compresses an image, and a method thereof as well as a storage medium.

[0002]

[Prior Art]

In recent years, scanners have become widely used and thereby documents have been progressively computerized. Retaining a computerized document in full color requires approximately 24 M bytes in the case of A4 size at 300 dpi, which causes tight memory conditions for retaining the document and is not a size capable of being sent to others as an attachment to a mail.

[0003]

On the other hand, JPEG is known for a full color image compression. Although the JPEG has a very high

effect and a good image quality in compression of natural images such as photos, image degradation called "mosquito noise" which JPEG-compresses a high frequency part such as a character portion is generated and a compression ratio is also poor. Consequently, first, an image is segmented into areas, and the JPEG compression is performed with respect to a ground portion from which a character area has been extracted. Moreover, an MMR compression or a ZIP compression is applied to a character area portion having color information. Thereby, images resulting from the respective compressions are obtained.

[0004]

On the other hand, there has been a representation method of transmitting the JPEG image at a white portion and putting a representative character color on a black portion when these images are decompressed.

[0005]

[Problems That the Invention is to Solve]

However, in the conventional method, at an area determined as a character, a color reduction process has been performed with respect to the entire character area to generate a color-reduced image. Therefore, a color having a low proportion of being used in the character area is also extracted as the representative color, which has been a disadvantage of an increased

number of colors in the color-reduced image and a poor compression ratio.

[0006]

The present invention has been made in view of the above described problems, and it is an object of the present invention to improve the compression ratio of the image by reducing the number of the colors in the color-reduced image.

[0007]

[Means of Solving the Problems]

In order to achieve the object of the present invention, for example, an image processing apparatus of the present invention is provided with a configuration as described below. In other words, the image processing apparatus of the present invention includes character area detection means for, if a character area is included in an image, detecting the above described character area, ground image generation means for generating a ground image in which a character portion included in the character area has been filled with a predetermined color, palette generation means for generating palettes of colors representing the character area, and color-reduced image generation means for, in a first color-reduced image of the above described character area, in which if the number of the palettes of the colors in the character area is one, an image in which the above

described character area has been binarized has been set to the color-reduced image of the above described character area, and if the number of the palettes of the colors in the character area is multiple, the color-reduced image has been generated by using the palettes of the colors in the above described character area, generating a second color-reduced image of the above described character area by extracting a representative color in the character portion included in the character area of the above described first color-reduced image and drawing pixels constituting the above described character portion by using the above described representative color.

[0008]

The image processing apparatus of the present invention further includes binarization means for binarizing the image, wherein the above described character area detection means detects the character area included in the image by using a binarized image of the above described image generated by the above described binarization means.

[0009]

The image processing apparatus of the present invention further includes segmentation means for segmenting the image into areas of a predetermined size.

[0010]

Moreover, the above described ground image

generation means further has average color calculation means for calculating an average color of colors in areas other than the character portion in the character area, and the above described character portion is filled by using the average color calculated by the above described average color calculation means.

[0011]

Moreover, the image processing apparatus of the present invention further includes JPEG compression means for JPEG-compressing the ground image generated by the above described ground image generation means.

[0012]

Moreover, the image processing apparatus of the present invention further includes color-reduced image compression means for compressing the color-reduced image of the character area generated by the above described color-reduced image generation means, with a compression method depending on the number of the palettes of the colors in the above described character area.

[0013]

[Embodiments of the Invention]

Hereinafter, according to the accompanying drawings, the present invention will be described in detail according to preferred embodiments.

[0014]

[First Embodiment]

Figure 1 shows a configuration of an image processing apparatus of this embodiment for generating a compressed data 1A which will be described below, and processes (processing results) in its respective units. Reference numeral 101 denotes an original image. Reference numeral 102 denotes an image binarization unit which inputs the original image 101 and performs an optimal binarization of the image. Reference numeral 103 denotes a full-page binary image binarized by the image binarization unit 102. Reference numeral 104 denotes a character area detection unit which inputs the full-page binary image 103, detects a character area in this image and generates character area coordinates 112. Reference numeral 105 denotes a character portion filling unit which extracts an area in the original image 101 positionally corresponding to a black area in the full-page binarized image 103, from the original image 101, fills the extracted area with a surrounding color and generates an image A. Reference numeral 106 denotes a reduction unit which inputs the image A and generates an image B by reducing the image A. Reference numeral 107 denotes a JPEG compression unit which inputs the image B and generates a compression code X 113 by JPEG-compressing the image B. Reference numeral 108 denotes a character color extraction unit which inputs the character area coordinates 112, calculates an original image color of

a black portion in the full-page binarized image 103 while referring to the original image 101 and the full-page binarized image 103 within the coordinates, generates multiple palettes 114, and performs a color reduction process with respect to the original image 101 according to the palettes 114. Reference numeral 109 denotes color-reduced images of multiple character areas color-reduced by the character color extraction unit 108. Reference numeral 110 denotes an MMR compression unit which inputs the color-reduced images 109 and generates multiple compression codes Y 115 by MMR-compressing the color-reduced images 109 when the color-reduced images 109 are 1 bit (m=1). Reference numeral 111 denotes a ZIP compression unit which inputs the color-reduced images 109 and generates multiple compression codes Z 116 by ZIP-compressing the color-reduced images 109 when the color-reduced images 109 are more than or equal to 2 bits (m>1). Finally, data 112 to 116 are integrated in 1A and this becomes the compressed data.

[0015]

Figure 3 shows a flowchart of a process until the character area is extracted from the original image 101. It should be noted that the original image 101 is assumed as a color image.

[0016]

At step S301, the original image 101 is inputted,

a luminance conversion is performed while reducing a resolution by thinning out the image, and a luminance image J is generated. For example, if the original image is 300-dpi, 24-bit RGB, an arithmetic operation of Y=0.299R+0.587G+0.114B is performed for every four pixels in both vertical and horizontal directions, and the image J having a luminance value Y is generated. The image J becomes a 75-dpi, 8-bit image. At step S302, a histogram of luminance data of the image J is formed and a binarization threshold T is calculated.

[0017]

At step S303, the luminance image J is binarized with the binarization threshold T, and the full-page binarized image 103 is generated. At step S304, a contour tracing is performed with respect to black pixels in the full-page binarized image 103, and all black areas are labeled. At step S305, character-like areas in the black areas are determined. In this determination, determination of the character-like areas (text blocks) is used according to a block discrimination method described in Japanese Patent Laid-Open No. 06-068301.

[0018]

Next, at step S306, the areas which should be integrated are integrated to each other in accordance with shapes or positions of the black areas. Moreover, at this step, the coordinates of the respective

character areas and the coordinates of the area for each one character have also been detected.

[0019]

An example of the above described process will be shown. For example, if a color manuscript shown in Figure 4 is inputted, the luminance conversion is performed while thinning out the color manuscript, and the histogram thereof is formed, the histogram becomes as shown in Figure 5. If the threshold T=150 is calculated by using data such as an average and a variance from this histogram, and the image shown in Figure 4 is binarized by using this threshold T, the binarized image (the full-page binarized image 103) becomes as shown in Figure 6. If the contour tracing is performed with respect to the black pixels in Figure 6 to label all, and for example, only collections of the black pixels having widths less than or equal to a predetermined threshold or heights less than or equal to a predetermined threshold are permitted as the characters, the collections of the black pixels shown in Figure 7 become the character areas (it is just imagery and such an image is not actually generated).

[0020]

If necessary, when these collections of the black pixels are grouped in accordance with positional proximity or matching widths or heights, 17 character areas can be detected as shown in Figure 8. Coordinate

data on these character areas is the character area coordinates 112 in Figure 1.

[0021]

Next, an example of a process in the character portion filling unit 105 by using the original image and the full-page binarized image (binary image) will be described by using respective images shown in Figure 10 and a flowchart of the same process shown in Figure 11. Figure 10(a) is the original image which will be used below. It is assumed that the binary image of one character area shown in the same Figure (b) has been obtained from this original image.

[0022]

At step S1101, the original image is segmented into 32×32 areas (hereinafter referred to as parts), and the process is performed for each part. Figure 10(c) shows how the original image has been segmented into parts. With respect to 6 parts 00 to 10, since there is no character area at a branch of step S1103, no process is performed. With respect to a part 11, since the character area is included, the process proceeds to step S1104. At step S1104, with reference to an area of the binary image corresponding to the part 11, an average value (average color) ave_color of RGB values (or may be any values such as YUV) of the color image corresponding to a white portion of this area is calculated. At step S1105, at this time, with

reference to the corresponding binary image, the above described ave_color is assigned to the color image corresponding to the black pixels. The above process is repeated with respect to parts 12, 13, 21, 22 and 23 in which the character areas exist. With respect to other parts, since there is no character area, no process is performed. In this way, the portions where the characters have existed have been able to be filled with the average value of neighboring pixels.

[0023]

This image (image A) is reduced by the reduction unit 106. In this embodiment, the reduction is performed by a simple thinning. Incidentally, an order of this reduction process and the character portion filling process may be reversed. In that case, consideration must be given to any positional shift between the binary image and the color image.

[0024]

Next, a flowchart of a process in the character color extraction unit 108 is shown in Figure 12. Although the full-page binary image 103 has been used as the binary image, the binary image is not limited thereto, and for example, only the coordinates of the character areas and the color image are inputted, the color image is binarized again, and its result may be used to perform a process of calculating a representative color as will be described below.

[0025]

At step S1201, a counter num indicating the number of extracted colors is reset to 0. Since the process is performed with respect to each of all extracted character areas, it is checked whether or not there are any unprocessed character area coordinates at step S1202, and if there are the unprocessed character area coordinates, the process proceeds to step S1203, and if there are no unprocessed character area coordinates, the process is terminated.

[0026]

At step S1203, a thinning process is performed with respect to the binary image corresponding to the character area coordinates so as to reduce black corresponding to a transitional portion from a ground to a character portion, and a new binary image newbi is generated. Next, at step S1204, an RGB 3D histogram of the original image corresponding to the black pixels of the new binary image newbi is formed. On this occasion, if the histogram is normally formed, for example, when the inputted image is assumed as 8-bit RGB, a histogram of 256×256×256 is required. Considering that the resolution is required for the character portion but tone is not required, and also that it is better to ignore some difference in pixel values in the calculation of the representative color while reducing variation in reading by a scanner and the like, such a

detailed histogram is not required. Therefore, in this example, the RGB 3D histogram of high 5 bits is formed. When this histogram is formed, a total number of the black pixels existing in the character area, pixelnum is also calculated. It should be noted that, although an RGB space has been used in this embodiment, another color space such as YUV may be used. Moreover, although the 3D histogram has been formed, three 1D histograms for the respective colors may be formed.

[0027]

At step S1205, a maximum value is calculated from the RGB 3D histogram. Although the histogram of only high 5 bits has been already formed and a noise due to the variation in the scanner has been reduced in this example, it is possible to detect an original maximum value across two histograms as shown in Figure 13 by calculating a maximum value of a sum of adjacent values in the histograms. Specifically, since it is the 3D histogram, it is conceivable that the maximum value of a total value of a total of seven histogram values, that is, a histogram value at a noted point, two histogram values adjacent in an R axis direction, two histogram values adjacent in a G axis direction, and two histogram values adjacent in a B axis direction is detected and the like. The maximum value detected in this way is assigned to colR[num], colG[num], colB[num].

[0028]

At step S1206, the histogram values positioned within a square which has been enlarged, for example, by 3 steps (=haba) respectively centering around the maximum value detected at step S1205, are set to 0. A description of the square is shown in Figure 15. Figure 15 shows the 3D histogram, and it is assumed that a portion denoted by a black dot is colR[num], colG[num], colB[num]. A total of 7×7×7 which has been enlarged by 3 steps respectively centering around the point is the above described square. Here, 3 steps correspond to 24 levels in 256 tones since it is the histogram of high 5 bits. This is only an example and the steps are not limited thereto. After the histogram values within this square are subtracted from pixelnum, 0 is assigned. At step S1207, the above described variable num is incremented by one.

[0029]

At step S1208, it is checked whether or not pixelnum is more than or equal to a previously decided threshold thre1, and if pixelnum is more than or equal to thre1, the process proceeds to step S1205, and if pixelnum is less than thre1, the process proceeds to step S1202.

[0030]

The above process is repeated with respect to all character areas, and thereby the palettes of all character areas are generated. Next, a flowchart of a

process in a color reduction unit 1082 within the character color extraction unit 108 is shown in Figure 19 and will be described below.

[0031]

If the number of the palettes of the character area has been 1 (step S1901), a character area portion of the inputted full-page binarized image 103 is cut out to generate a one-portion binary image (step S1907). It becomes the color-reduced image of the character area.

[0032]

On the other hand, if the number of the palettes of this area is more than or equal to 2 (step S1901), the color reduction unit 1082 inputs the original image 101 and the full-page binarized image 103, and first, without using character segmentation information, sorts the value in the original image of the pixel which is black in the binary image within the character area, into the value of the palette, and generates the color-reduced image (step S1902). Then, the representative color is extracted for each one character by using coordinate information on each one character according to the above described color-reduced image and the character segmentation information (step S1903), and character pixels in that one character area are redrawn with the representative color (step S1904).

[0033]

It should be noted that here the character segmentation information is obtained by a method disclosed in Japanese Patent Laid-Open No. 06-068301, and the method is a method of obtaining the coordinate information on each one character by a character cutout process. Specifically, a line segmentation process and the character cutout process are performed with respect to a block determined as a text area, and the coordinate information (character segmentation information) on each one character is obtained.

[0034]

This process is repeated with respect to all character coordinates, and thereby the color-reduced image 109 is obtained. Among the generated palettes, a palette color which has not been used in the color-reduced image 109 is deleted from the palettes (step S1905). With respect to an allocated number of bits, since 1 data is required for indicating transparence as a white portion in the binary image, when the number of the palettes is 3, it becomes 4 by adding 1 transparence data and the allocated number of bits becomes 2 bits, and when the number of the palettes is 4, it becomes 5 by adding 1 transparence data and the allocated number of bits becomes 3 bits. This number of bits is in accordance with the number of bits capable of being represented in an image format which is finally adapted. On this occasion, for example, if

the number of the palettes is significantly large and it can be determined that effects of improving an image quality and improving a compression ratio due to multicoloring cannot be seen, it is also conceivable that the multicoloring is not performed and the image is saved as a ground image. In that case, the character area has to be deleted from the character area coordinate information 112. Moreover, it has to be deleted from the character area coordinate information before the process in the character portion filling unit 105 is performed. The process according to the flowchart shown in Figure 19 is performed with respect to all character areas (step S1906).

[0035]

If the color-reduced image 109 generated in this way is 1 bit, the color-reduced image 109 is MMR-compressed in the MMR compression unit 110 and the compression code Y is generated. Moreover, if the color-reduced image 109 is more than or equal to 2 bits, the color-reduced image 109 is ZIP-compressed in the ZIP compression unit 111 and the compression code Z is generated. On the other hand, the JPEG compression is performed with respect to the reduced image B, and the compression code X is generated. A format (compressed data 1A) which have integrated five elements, that is, the character area coordinates 112, the palettes 114, the compression code X 113, the compression codes Y 115

and the compression codes Z 116 is generated if necessary.

[0036]

It should be noted that, for example, if all character areas are the binary images, since the color-reduced images generated in the character color extraction unit 108 are 1 bit, the compression codes Z 116 are not generated in this case. In other words, the data included in the compressed data 1A is not always limited to the above five elements, and the data may be four elements as described above, depending on the character areas. The same also applies to, for example, the case where all character areas are the color images. As an example of the format integrating the five elements, PDF of Adobe or the like is conceivable. The PDF of Adobe is a format that can be displayed by a free application called Acrobat Reader distributed by Adobe. This can prevent a trouble such as inability of a reception side to open a file because of absence of an application that was used to generate a document. As other formats, XML and the like are available. XML is a description language for exchanging or distributing documents or data through a network.

[0037]

Figure 2 shows a configuration of the image processing apparatus of this embodiment for

decompressing the compressed data 1A and also processes in its respective units.

[0038]

Reference numeral 201 denotes JPEG decompression means which inputs the compression code X 113 and performs a JPEG decompression process to generate a multivalued image E. Reference numeral 202 denotes an enlargement unit which inputs the multivalued image E and performs an enlargement process. Reference numeral 203 denotes a multivalued image F enlarged by the enlargement unit 202.

[0039]

Reference numeral 204 denotes an MMR decompression unit which inputs the compression codes Y 115 and generates binary images G 205. Reference numeral 206 denotes a ZIP decompression unit which inputs the compression codes Z 116 and generates multicolor images H 207. Reference numeral 208 denotes an image integration unit which inputs the character area coordinates 112 and the corresponding palettes 114, as well as the binary images G 205 and/or the multicolor images H 207, and if pixel data of the binary images or the multivalued images represents the transparence, selects colors of the pixels of the multivalued images F 203, or otherwise selects the corresponding palette colors, and generates an image I (decompressed image) 209 which is a final image.

[0040]

Figure 14 shows a process of the integration processing unit 208. First, Figure 14(a) shows a result of JPEG-decompressing the compression code X. Although the image of Figure 10 has been used for this, the data has the pixel values slightly different from Figure 10(c) by using an irreversible quantization method of the JPEG compression. However, variation in the pixel values is smaller in the case of using the same quantization table, in comparison with the case of compressing the original image before its character portions are extracted, by a JPEG irreversible compression method. In this example, the image included in the character area (a result of decompressing the compression codes Y 115) is represented by 1 bit of the binary image as shown in Figure 14(b), and its palette is assumed as R=20, G=30, B=225. With reference to the binary image shown in Figure 14(b), data on the palette color (20, 30, 255) is put on portions corresponding to the black pixels on the image shown in Figure 14(a), and finally an image as shown in Figure 14(c) is generated. This becomes the decompressed image 209. If the image included in the character area is the multicolor image, the number of the palettes is changed. For example, in the case of 2 bits, the palettes allocated to four pixel values of 00, 01, 10 and 11 are applied. Among them, one

pixel value indicates the transparence, and for example, if it is 00, the pixel having the value of 00 selects the pixel of the image shown in Figure 14(a).

[0041]

As described above, according to the image processing apparatus and the method thereof in this embodiment, if the number of the palettes within the character area is 1, this character area is represented by using the binary image. On the other hand, if the number of the palettes is more than or equal to 2, the respective characters are represented with the respective representative colors. As a result, colors having a low proportion of being used in the character area are not included in the color-reduced image, and therefore an image having a good compression efficiency with less number of colors can be generated.

[0042]

[Second Embodiment]

Although the original image (color image) has been binarized as the character area extraction process in the first embodiment, the process is not limited thereto and there is a method of applying a differential filter to the original image, calculating an edge amount of all pixels with neighboring pixels, binarizing the edge amount to obtain the binary image, and similarly performing the contour tracing with respect to the binary image to detect the character

areas. A configuration of the image processing apparatus which executes this method will be as shown in Figure 16.

[0043]

In the configuration example of Figure 16, since a differentially binarized image 1703 cannot be used for the character portion filling and the character color extraction, a binary image (partial binary image 1706) is generated for each character area. This binary image may be binarized, for example, with the threshold T calculated by a character area detection unit 1704, or a histogram is formed for each area and an optimal binarization threshold may be calculated depending on the character area. In comparison with the full-page histogram shown in Figure 5, a luminance histogram of one portion of the character area can be expected to be a simple form as shown in Figure 9, and thereby the threshold is easily determined. Reference numeral 901 denotes a collection of ground colors, and reference numeral 902 denotes a collection of character colors.

[0044]

In the first embodiment, a character having a high luminance on a ground having a low luminance (reversed character) cannot be processed. However, if the character area is detected by this differential process, this reversed character area can also be

detected. Reference numeral 1702 denotes a differential processing unit, which applies a differential filter as shown in Figure 17 centrally around a noted pixel and performs the binarization so that the pixel is black if its absolute value exceeds the threshold or the pixel is white if its absolute value does not exceed the threshold. Figure 17(a) shows a linear differential filter, in which an upper filter can detect horizontal lines and a lower filter can detect vertical lines. Hatched lines can be detected by using a sum of absolute values of two filters. Moreover, a filter for the hatched lines may be used. Figure 17(b) shows a quadratic differential filter which accommodates all directions. Also in the quadratic differential filter, a horizontal direction filter and a vertical direction filter can be generated. Such a filter is applied to all pixels to generate the differentially binarized image 1703. At this time, the resolution can also be simultaneously reduced by applying the filter while thinning out the pixels. If the process from step S304 of Figure 3 is performed with respect to the binary image generated as described above, the character area coordinates including the reversed character can be detected.

[0045]

In a configuration directed also to this reduced character, a binarization unit 1705 also has to

accommodate the reversed character. In the first embodiment, it has been assumed that only the pattern shown in Figure 9 is entered. However, in the case of this configuration in which the reversed character area can also be extracted as the character area, three patterns shown in Figure 18 will be mainly entered. Figure 18(b) is a diagram showing a luminance distribution of the character and the ground in the case of the reversed character. Moreover, Figure 18(c) is a diagram showing the respective luminance distributions in the case where there are two colors of a black character and a white character on the same gray ground. In consideration of these three patterns, the binarization unit 1705 may detect a point A and a point B, and perform the binarization process so that an area between A and B is white and other areas are black. Alternatively, without considering the pattern shown in Figure 18(c), one threshold for dividing the ground and the character portion may be detected, and a process of performing a reversal in the case of a reversed pattern may be performed.

[0046]

If the reversed character area is also accommodated in this way, the reversed character area which has remained on the JPEG-compressed image in the first embodiment is also smoothed by the character portion filling, which also provides the good

compression efficiency and also enables its reversed character portion to be compressed without degradation in the resolution or degradation due to a mosquito noise.

[0047]

Moreover, although the character area extraction process has been performed by using the binary image in the first embodiment and this embodiment which uses the above described differentiation, the process is not limited thereto, and the character area may be inferred with reference to the multivalued image's own pixel values.

[0048]

In the first embodiment, a degree of the reduction in the reduction unit 106 has been constant in any image. However, it is not limited thereto, and for example, a reduction parameter determination unit which determines a reduction parameter for a resolution conversion (for example, one-half, one-quarter and the like) may be provided. As a method of realizing this, for example, an orthogonal transformation is performed for each 8×8 on a full page of the image A, and the reduction can be adjusted so that the reduction is by one-half if the number of existing areas having a large coefficient in a high frequency part of a result of the orthogonal transformation is more than or equal to a threshold, the reduction is by one-quarter if it is

less than or equal to the threshold, or the like. This parameter is not limited to two stages, and for example, the parameter can also be three stages (no reduction, one-half and one-quarter). This avoids an extreme reduction in the high frequency part and provides an effect of avoiding degradation in the image quality. As this reduction parameter determination, a method of applying the differential filter to the image and switching according to a summation of its absolute values is also conceivable. For example, it is conceivable that the reduction is not performed if a summation of differences between adjacent pixel values is more than or equal to a threshold m, the reduction is by one-half if it is more than or equal to n, the reduction is by one-quarter if it is less than n, or the like.

[0049]

It should be noted that a configuration of an apparatus for decoding the compressed data 1A generated by the image processing apparatus in this embodiment may be the apparatus having the configuration shown in Figure 2.

[0050]

[Other Embodiments]

In the above described embodiments, the number of tiles is not required to be multiple as shown in Figure 2 or Figure 5, and the entire image may be processed as

one tile. In this case, it is not necessary to extract a characteristic amount for each tile.

[0051]

Furthermore, the present invention is not limited only to the apparatus and the method for realizing the above described embodiments, and the case where software program codes for realizing the above described embodiments are supplied to a computer (a CPU or an MPU) in the above described system or apparatus and the computer in the above described system or apparatus causes the above described various devices to operate according to these program codes to realize the above described embodiments is also included in the category of the present invention.

[0052]

Moreover, in this case, the above described software program codes themselves realize functions of the above described embodiments, and the program codes themselves and means for supplying the program codes to the computer, that is, specifically, a storage medium storing the above described program codes are included in the category of the present invention.

[0053]

As the storage medium storing the program codes as described above, for example, a floppy (registered trademark) disk, a hard disk, an optical disk, a magneto optical disk, a CD-ROM, a magnetic tape, a

nonvolatile memory card, a ROM and the like can be used.

[0054]

Moreover, not only in the case where the above described computer controls the various devices only according to the supplied program codes and thereby the functions of the above described embodiments are realized, but also in the case where the above described program codes collaborate with an OS (Operating System) running on the computer or other application software and the like and thereby the above described embodiments are realized, such program codes are included in the category of the present invention.

[0055]

Furthermore, the case where these supplied program codes are stored in a memory provided in a function expansion board in the computer or a function expansion unit connected to the computer, and subsequently the CPU or the like provided in the function expansion board or the function expansion unit performs part or all of actual processes based on instructions of the program codes, and the above described embodiments are realized by those processes, is also included in the category of the present invention.

[0056]

If the present invention is applied to the above described storage medium, the program codes

corresponding to the flowcharts (shown in Figure 3 and/or Figure 11, and/or Figure 12, and/or Figure 19) described above are stored in the storage medium.

[0057]

[Effect of the Invention]

As described above, according to the present invention, the compression ratio of the image can be improved by reducing the number of the colors in the color-reduced image.

[Brief Description of the Drawings]

[Figure 1]

Figure 1 is a block diagram showing a configuration of an image processing apparatus for generating a compressed data 1A which will be described below, and processes (processing results) in its respective units in a first embodiment of the present invention.

[Figure 2]

Figure 2 is a block diagram showing a configuration of the image processing apparatus for decompressing the compressed data 1A and also processes in its respective units in the first embodiment of the present invention.

[Figure 3]

Figure 3 is a flowchart of a process until a character area is extracted from an original image 101.

[Figure 4]

Figure 4 is a diagram showing a color manuscript used in the first embodiment of the present invention.

[Figure 5]

Figure 5 is a histogram of a luminance value of the color manuscript shown in Figure 4.

[Figure 6]

Figure 6 is a diagram showing an image in which the color manuscript shown in Figure 4 has been binarized.

[Figure 7]

Figure 7 is a diagram showing an image in the case where a contour tracing is performed with respect to black pixels of the image shown in Figure 6 to label all, and for example, only collections of the black pixels having widths less than or equal to a predetermined threshold or heights less than or equal to a predetermined threshold have been permitted as characters.

[Figure 8]

Figure 8 is a diagram showing an image in the case where the collections of the black pixels have been grouped in accordance with positional proximity or matching widths or heights in the image shown in Figure 7.

[Figure 9]

Figure 9 is a histogram for describing luminance values of ground colors and character colors in a

second embodiment of the present invention.

[Figure 10]

Figure 10(a) is a diagram showing an original image, Figure 10(b) is a diagram showing a binary image of a character area, and Figure 10(c) is a diagram showing how the original image shown in (a) has been segmented into parts.

[Figure 11]

Figure 11 is a flowchart of a process in a character portion filling unit 105 by using the original image and a full-page binarized image (binary image).

[Figure 12]

Figure 12 is a flowchart of a process in a character color extraction unit 108.

[Figure 13]

Figure 13 is a diagram showing an original maximum value across two histograms.

[Figure 14]

Figure 14(a) is a diagram showing a result of JPEG-decompressing a compression code X, Figure 14(b) is a diagram showing a result of decompressing compression codes Y (binary image), and Figure 14(c) is a diagram showing an image in which data on the image shown in (b) is put on the image shown in (a).

[Figure 15]

Figure 15 is a diagram for describing a square

for detecting a maximum value in an RGB 3D histogram.

[Figure 16]

Figure 16 is a block diagram showing a configuration of the image processing apparatus in a second embodiment of the present invention.

[Figure 17]

Figure 17(a) is a diagram showing a linear differential filter which detects vertical lines and horizontal lines, and Figure 17(b) is a diagram showing a quadratic differential filter which accommodates all directions.

[Figure 18]

Figures 18(a) to (c0) are diagrams showing luminance distributions of three patterns of an image and a ground image of the character area.

[Figure 19]

Figure 19 is a flowchart of a process in a color reduction unit 1082 within the character color extraction unit 108.

Translation of Drawings

Figure 1

101	ORIGINAL IMAGE
102	IMAGE BINARIZATION UNIT
103	FULL-PAGE BINARIZED IMAGE
104	CHARACTER AREA DETECTION UNIT
105	CHARACTER PORTION FILLING UNIT
106	REDUCTION UNIT
107	JPEG COMPRESSION UNIT
108	CHARACTER COLOR EXTRACTION UNIT
109	COLOR-REDUCED IMAGES
110	MMR COMPRESSION UNIT
111	ZIP COMPRESSION UNIT
112	CHARACTER AREA COORDINATES
113	COMPRESSION CODE X
114	PALETTES
115	COMPRESSION CODES Y
116	COMPRESSION CODES Z
1082	COLOR REDUCTION UNIT
#1	IMAGE A
#2	IMAGE B
#3	NUMBER OF BITS IN IMAGE m
#4	PALETTES
#5	m-BIT IMAGE

Figure 2

112	CHARACTER AREA COORDINATES

113 COMPRESSION CODE X

114 PALETTES

115 COMPRESSION CODES Y

116 COMPRESSION CODES Z

201 JPEG DECOMPRESSION UNIT

202 ENLARGEMENT UNIT

203 MULTIVALUED IMAGE F

204 MMR DECOMPRESSION UNIT

205 BINARY IMAGES G

206 ZIP DECOMPRESSION UNIT

207 MULTICOLOR IMAGES H

208 IMAGE INTEGRATION UNIT

209 DECOMPRESSED IMAGE I

#1 MULTIVALUED IMAGE E

Figure 3

S301 PERFORM LUMINANCE CONVERSION WITH RESPECT TO INPUTTED COLOR IMAGE WHILE THINNING OUT IMAGE, AND GENERATE LUMINANCE IMAGE J

S302 FORM HISTOGRAM OF LUMINANCE AND CALCULATE BINARIZATION THRESHOLD T

S303 BINARIZE IMAGE J WITH T AND GENERATE FULL-PAGE BINARIZED IMAGE 103

S304 PERFORM CONTOUR TRACING WITH RESPECT TO BLACK PIXELS AND LABEL ALL BLACK AREAS

S305 DETERMINE CHARACTER-LIKE AREAS IN BLACK AREAS

S306 INTEGRATE AREAS WHICH SHOULD BE INTEGRATED TO

EACH OTHER IN ACCORDANCE WITH SHAPES OR POSITIONS

Figure 4

#1 xxxxxxxxxxxx at the personal computer on your desk

#2 Personal computer banking will be familiar to you

Figure 6

#1 xxxxxxxxxxxx at the personal computer on your desk

#2 Personal computer banking will be familiar to you

Figure 7

#1 xxxxxxxxxxxx at the personal computer on your desk

#2 Personal computer banking will be familiar to you

Figure 9

#1 LUMINANCE

Figure 10

#1 GRADATION

#2 BLUE CHARACTERS

#3 WHITE

#4 BLACK

#5 BINARY IMAGE

#6 COLOR OF INSIDE ABC BECOMES AVERAGE VALUE COLOR OF PIXELS OTHER THAN ITS BLOCK CHARACTER FOR EACH BLOCK

Figure 11

S1101 SEGMENT IMAGE INTO 32×32 AREAS (PARTS)

S1102 IS THERE ANY UNPROCESSED PART?

S1103 IS THERE ANY CHARACTER AREA?

S1104 WITH REFERENCE TO CORRESPONDING BINARIZED IMAGE, CALCULATE AVERAGE COLOR ave_color OF WHITE PIXEL PORTION

S1105 WITH REFERENCE TO CORRESPONDING BINARY IMAGE, ASSIGN ave_color TO BLACK PIXEL PORTION

Figure 12

S1202 ARE THERE ANY UNPROCESSED CHARACTER AREA COORDINATES?

S1203 PERFORM THINNING PROCESS WITH RESPECT TO BINARY IMAGE AND GENERATE NEW BINARY IMAGE newbi

S1204 WITH REFERENCE TO Newbi, FORM RGB 3D HISTOGRAM OF ORIGINAL IMAGE CORRESPONDING TO BLACK PIXELS ON THIS OCCASION, ALSO CALCULATE NUMBER OF PIXELS Pixelnum

S1205 ASSIGN MAXIMUM VALUE FROM HISTOGRAM TO colR[num], colG[num], B[num]

S1208 SET HISTOGRAM VALUES POSITIONED WITHIN SQUARE WHICH HAS BEEN ENLARGED BY haba CENTERING AROUND MAXIMUM VALUE FROM RGB HISTOGRAM, TO 0

ON THIS OCCASION, SUBTRACT NUMBER OF PIXELS FROM pixelnum

Figure 14

#1 REPRESENTATIVE COLOR DATA R=20, G=30, B=255

#2 BLUE OF (20, 30, 255)

Figure 15

#1 WHITE

#2 7 Steps CENTERING AROUND EXTRACTED POINT

#3 BLACK

Figure 16

1701 ORIGINAL IMAGE

1702 DIFFERENTIAL PROCESSING UNIT

1703 DIFFERENTIALLY BINARIZED IMAGE

1704 CHARACTER AREA DETECTION UNIT

1705 BINARIZATION UNIT

1706 PARTIAL BINARY IMAGE

1707 CHARACTER PORTION FILLING UNIT

1708 REDUCTION UNIT

1709 JPEG COMPRESSION UNIT

1710 CHARACTER COLOR EXTRACTION UNIT

1711 COLOR-REDUCED IMAGES

1712 MMR COMPRESSION UNIT

1713 ZIP COMPRESSION UNIT

1714 CHARACTER AREA COORDINATES

1715 COMPRESSION CODE X

1716 PALETTES

1717 COMPRESSION CODES Y

1718 COMPRESSION CODES Z

#1 NUMBER OF BITS IN IMAGE m

#2 PALETTES

#3 m-BIT IMAGE

#4 COLOR REDUCTION UNIT

#5 WHEN =1 bit, EQUAL PORTION IS BINARY IMAGE

Figure 18

#1 CHARACTER

#2 GROUND

#3 LUMINANCE

Figure 19

S1901 NUMBER OF PALETTES?

S1902 SORT VALUE IN ORIGINAL IMAGE OF PIXEL WHICH IS BLACK IN BINARY IMAGE WITHIN CHARACTER AREA, INTO VALUE OF PALETTE, AND GENERATE COLOR-REDUCED IMAGE

S1903 EXTRACT REPRESENTATIVE COLOR FOR EACH ONE CHARACTER BY USING CHARACTER COORDINATES OF EACH ONE CHARACTER

S1904 REPRESENT EACH CHARACTER IN REPRESENTATIVE

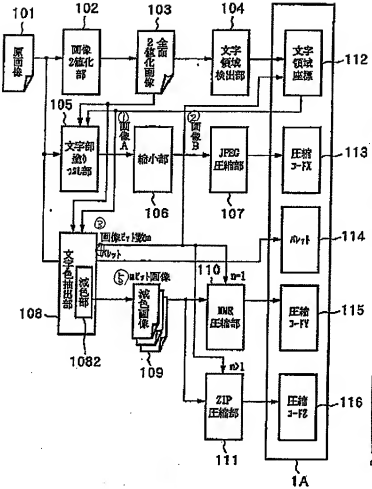
COLOR (GENERATE COLOR-REDUCED IMAGE AGAIN)

S1905 DELETE PALETTE COLOR WHICH HAS NOT BEEN USED

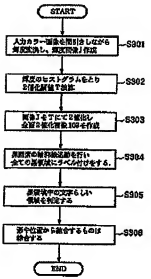
S1906 HAS PROCESS BEEN PERFORMED WITH RESPECT TO ALL CHARACTER AREAS?

S1907 GENERATE ONE-PORTION BINARY IMAGE

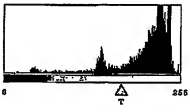
【図1】 Fig.1



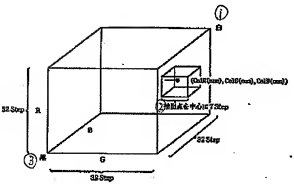
【図3】 Fig.3



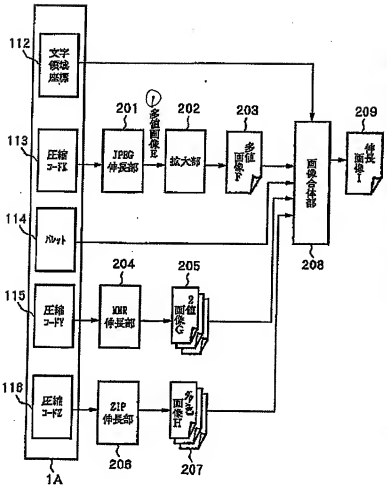
【図5】 Fig.5



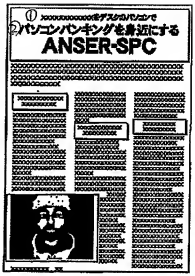
【図15】 Fig.15



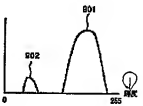
【図2】 Fig. 2



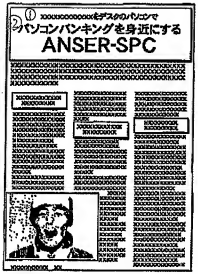
【図6】 Fig. 6



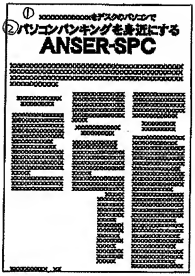
【図9】 Fig. 9



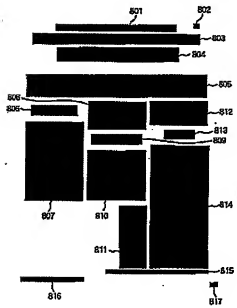
【図4】 Fig.4



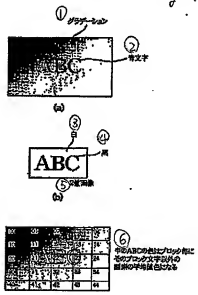
【図7】 Fig.7



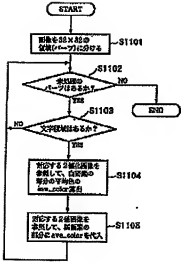
【図8】 Fig.8



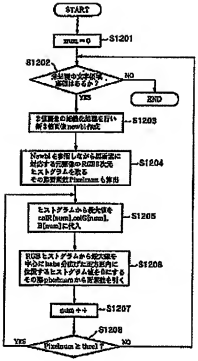
【図10】 Fig.10



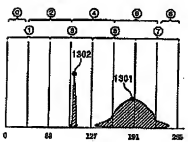
【図11】 Fig.11



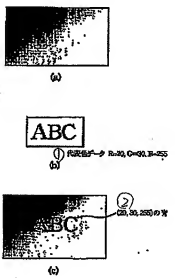
【図12】 Fig.12



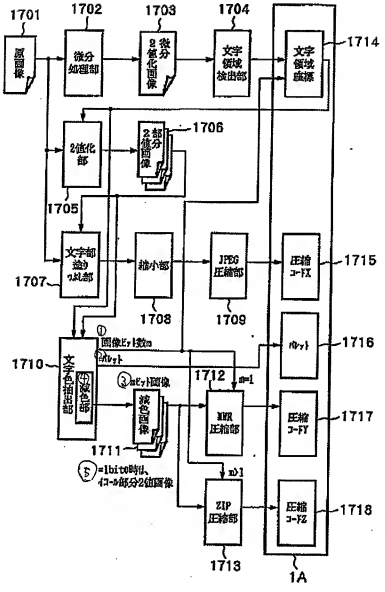
【図13】 Fig.13



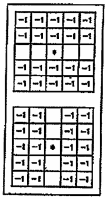
【図14】 Fig.14



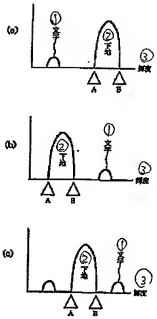
【図16】 Fig.16


1701
原画像
1702
微分処理部
1703
2値化画像
1704
文字領域検出部
1714
文字領域座標
2値化部
1706
2値化画像
1705
文字部抽出以外部
1707
縮小部
1708
JPEG圧縮部
1709
圧縮コードX
1715
1710
文字色抽出部
背景色抽出部
①画像ビット数n
②パレット
③nビット画像
1712
m=1
1711
背景色画像
MMR圧縮部
圧縮コードY
1717
⑤=1bitの時は、イコール部分2値画像
n>1
ZIP圧縮部
圧縮コードZ
1718
1713
1A

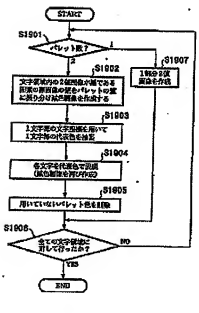
【図１７】 Fig.17



【図１８】 Fig.18



【図１９】 Fig.19



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